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Recommendation for giving loans using the Multi Objective Optimization method based on Ratio Analysis

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Abstract. Mekar Harapan Farmers' Cooperative, a cooperative which was dealing with savings and loans. This cooperative has a constraint in lending operations, namely the provision of lending recommendations in accordance with the rules that are less effective and efficient in determining the feasibility decisions for a large number of loan applications so that they are less selective in making decisions. To assist cooperative management in determining the eligibility of loans by providing a fair, objective and transparent assessment, a system of recommendations is needed that can help the selection process in accordance with predetermined criteria. The methodology used in this system is the method of Multi Objective Optimization on The Base of Ratio Analysis (MOORA) because this method has a good level of selectivity in determining an alternative. This system will be used as a medium of evaluation by the MOORA method of several loan applications that have been registered in the system conducted by members and managed by officers, then approval by supervisors. With this Loan Recommendation, it is expected to make it easier for officers in the selection process to determine the eligibility of a loan so that the results of the assessment can be known easily, quickly, and accurately.

6 Introduction

Law No. 17 of 2012 concerning Cooperatives that a Cooperative is a legal entity established by an individual or a Cooperative legal entity, with the separation of the wealth of its members as capital to run a business, which fulfils common aspirations and needs in the economic, social and cultural fields in accordance with values and principles Cooperative [1].

To assist cooperative management in determining the feasibility of a loan by providing a fair, objective and transparent assessment of lending so as to avoid the risk of bad credit, a recommendation system is needed to assist the selection process in accordance with the rules and criteria determined by the cooperative itself. The method used is the Multi Objective Optimization method on The Base of Ratio Analysis (MOORA). This method was chosen because it has a good level of selectivity in determining an alternative [2]. The advantage is that it is very simple, stable, and strong, even this method does not require an expert in mathematics to use it and requires simple mathematical calculations. This method also has more accurate and targeted results in assisting decision making. When compared with other methods the Moora method is more easily implemented [3].



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Several studies of decision support systems use the MOORA method, one of which has been done by Samuel Manurung regarding the selection of the best teachers and staff using the MOORA method. This method was chosen because it can make decisions effectively by processing data quickly and as expected, the results of the study are able to provide good decisions in a selection of teachers and employees because they can find out the accuracy of the values obtained by the system [4]. Another study conducted by Mesran et al. on the selection of participants for public health insurance (Jamkesmas) applies the MOORA method. This method was chosen because it is quite easy to use and the steps to solve it are quite simple, in that study, those who are entitled to receive JAMKESMAS based on predetermined criteria where these criteria greatly affect the results of calculations in the MOORA method. This system can overcome the problem in selecting JAMKESMAS participants to be more systematic and targeted to the people who need it [5].

2. Methodology

The methodology used in this study consists of data collection stages and system development methods. The data collection stage includes field studies and literature studies [6].

2.1. Data collection stage

2.1.1. Field study. This field study includes observation and interviews. observation is a technique of collecting data by conducting research and direct review of the problems taken. Whereas interview is a technique of collecting data by holding question and answer directly which has to do with the topic taken.

2.1.2. Literature review. Library study is a method by taking data from several books as a theoretical foundation material to obtain a statement that can support the preparation of research.

2.2. Method of development system

Software development methods used in this study are:

2.2.1. Identify system requirements. This stage is carried out identification of system requirements needed in system development.

2.2.2. Development of prototype. This stage is carried out system design using related tools in system development.

2.2.3. Coding. This stage is carried out from the initial design into the codes that are built.

2.2.4. Testing. This stage is done by testing the system with the aim of measuring the system that has been developed to run well, correctly and in accordance with user needs. If there are deficiencies, the system will be improved before the system is used.

2.2.5. Implementation. After all stages have been completed and the test results show the appropriate results, the system can be implemented and ready for use by the user while continuing to carry out regular maintenance.

3. Result

3.1. Multi objective optimization based on ratio analysis (MOORA) method

According to Attri and Grover the Moora method is applied to solve many economic, managerial and construction problems in a company or project. This method has a good level of selectivity in determining an alternative. The approach taken by MOORA is defined as a process simultaneously to optimize two or more conflicting criteria on several constraints [7].

The advantage of MOORA is that it is very simple, stable, and strong, even this method does not require an expert in mathematics to use it and requires simple mathematical calculations. In addition, this method has more accurate and targeted results in assisting decision making. When compared with other methods the MOORA method is even simpler and easier to implement [8][9].

3.2. Assessment process using the Multi Objective Optimization based on Ratio Analysis (MOORA) method

The following is determining the type of each criterion, which includes the benefits or cost criteria [10,11]. This determination is based on information:

- Benefit: The type of criteria if the greater the value, the better, if the smaller the value is not good.
- Cost: Type of criteria if the value is smaller, the better, if the greater the value is not good.

There are criteria that will be considered in the assessment process. It was intended to determine the applicants who would get loans in the selection process for the eligibility of loans.

Table 1. Types of each criteria.

| Code | Criteria Name | Type |
|------|-------------------|---------|
| K1 | Membership Status | Benefit |
| K2 | Loan Status | Benefit |
| K3 | Great Submission | Cost |
| K4 | The need | Benefit |
| K5 | Period of time | Cost |

Table 1 explains the names and types of criteria that will be used as a reference value in the loan requirements of the Mekar Harapan Farmers' cooperative. There is a membership type of benefit type, a type of benefit loan status, a large fee type submission, a benefit type requirement, and a cost type term.

Then there is a rating scale for each criterion that will be considered in the assessment process. This is intended to determine the priority of loan applicants with a scale value of 0-50. The value of 50 is the highest value of the criteria very good, the value of 40 is good, the value of 30 is sufficient, the value of 20 is less, the value of 10 is very less.

Table 2. Sub membership status criteria.

| Membership Status | Value |
|-------------------|-------|
| Active | 50 |
| Passive | 20 |

Table 2 explains the assessment of membership status criteria, the value is based on data from loan applicants. A score of 50 is the highest value of the membership status criteria. If the loan applicant is active, the member will get a value of 50 and a value of 20 if the member is passive. It is said to be an active member, when the diligent members (Saving, Borrowing and Paying) and those who are passive are registered members who still have old loans and are not repaid or the count in the last 10 months is not diligent (Saving, Borrowing and Paying).

Table 3. Sub loan status criteria.

| Loan Status | Value |
|-------------|-------|
| There is no | 50 |
| There is | 10 |

Table 3 explains the assessment of loan status criteria. If the loan applicant has no loan status, then the member will get a value of 50 and a value of 10 if the member has a loan status (still has a loan).

Table 4. Sub submission criteria.

| Great Submission | Value |
|------------------|-------|
| <= 3x deposits | 50 |
| > 3x deposits | 10 |

Table 4 describes the evaluation criteria for submission. If the loan applicant submits a loan that is less than 3 times the savings he has, he will get a value of 50 and a value of 10 if the loan applicant submits a loan in excess of 3 times his deposit.

Table 5. Sub requirement criteria.

| The Need | Value |
|------------------|-------|
| Start-up Capital | 50 |
| Get treatment | 40 |
| School | 30 |
| Basic food | 20 |
| Celebration | 10 |

Table 5 explains the assessment of requirements criteria. If the loan applicant submits a loan for business capital needs, it will get a value of 50 and a value of 40 if the loan applicant submits a loan for medical treatment purposes. Then the value of 30 for loan applicants with the needs of schools and for the needs of nine basic needs of borrowers get a value of 20 while for those applying for loans will need a value of 10.

Table 6. Sub period of time criteria.

| Period of time | Value |
|----------------|-------|
| 20 months | 20 |
| 10 months | 30 |
| 5 months | 50 |

Table 6 explains the evaluation of the time criteria. If the loan applicant submits a loan with a 20-month instalment period, then the value will be 20 and 30 for the loan applicant with the proposed tenor of 10 months, but if the loan applicant requests a loan with a 5-month instalment period, the applicant will get a value of 50. Because the faster the instalment period, the better, it is to reduce the risk of bad credit.

The MOORA calculation process in a case example with the initial data as follows:

Table 7. Alternative data (loan applicants).

| Code | Name | Membership Status | Loan Status | Great Submission | Requirement | Period of time |
|------|-----------|-------------------|-------------|------------------|------------------|----------------|
| A1 | Osin | Active | Ada | < 3x deposits | Start-up Capital | 20 |
| A2 | Idar | Active | There is no | > 3x deposits | School | 10 |
| A3 | Uju | Passive | There is no | > 3x deposits | Celebration | 20 |
| A4 | Dede Aga | Active | There is no | < 3x deposits | Basic food | 10 |
| A5 | H. Tatang | Passive | There is | > 3x deposits | Get treatment | 5 |

Table 7 is a table that contains loan application data recorded in the Mekar Harapan Farmers' Cooperative.

- The first step is inputting the criteria value for each alternative. Input the criteria value in an alternative where the value will be processed later, and the result will be a decision.

Table 8. Input the criteria value of each alternative.

| Code | Name | Membership Status | Loan Status | Great Submission | Requirement | Period of time |
|------|-----------|-------------------|-------------|------------------|-------------|----------------|
| A1 | Osin | 50 | 10 | 50 | 50 | 20 |
| A2 | Idar | 50 | 50 | 10 | 30 | 30 |
| A3 | Uju | 20 | 50 | 10 | 10 | 20 |
| A4 | Dede Aga | 50 | 50 | 50 | 20 | 30 |
| A5 | H. Tatang | 20 | 10 | 10 | 40 | 50 |

- The next step is deciding matrix. The next step is to decide matrix from the results of the rating scale according to the existing conditions based on the values in the table above and the decision matrix data (X) is obtained as follows:

$$X = \begin{pmatrix} 50 & 10 & 50 & 50 & 20 \\ 50 & 50 & 10 & 30 & 30 \\ 20 & 50 & 10 & 10 & 20 \\ 50 & 50 & 50 & 20 & 30 \\ 20 & 10 & 10 & 40 & 50 \end{pmatrix}$$

- Making a normalization matrix.

4 formation

X_{ij} : Alternative matrix j in criteria i

i : 1,2,3, ..., n is the order number of the attribute or criterion

j : 1,2,3, ..., m is an alternative sequence number

X^*_{ij} : Alternative Normalization Matrix j on criterion i

The next step is to determine the normalization value for each criterion from each alternative and make it a normalization matrix. By the way, the elements of the first column are divided by the root of the sum of the squares of the first column. Then the elements of the second column are divided by the sum of the squares of the second column, and so on.

Normalization calculation results

Table 9. Normalization calculation results.

| Alternative | Criteria | | | | |
|-------------|-------------------|-------------|------------------|-------------|----------------|
| | Membership Status | Loan Status | Great Submission | Requirement | Period of time |
| A1 | 0,55 | 0,11 | 0,69 | 0,67 | 0,28 |
| A2 | 0,55 | 0,57 | 0,14 | 0,40 | 0,42 |
| A3 | 0,22 | 0,57 | 0,14 | 0,13 | 0,28 |
| A4 | 0,55 | 0,57 | 0,69 | 0,27 | 0,42 |
| A5 | 0,22 | 0,11 | 0,69 | 0,54 | 0,70 |
| | Max | Max | Min | Max | Min |

Then the normalization value matrix is obtained as follows:

$$X^* = \begin{pmatrix} 0,55 & 0,11 & 0,69 & 0,67 & 0,28 \\ 0,55 & 0,57 & 0,14 & 0,40 & 0,42 \\ 0,22 & 0,57 & 0,14 & 0,13 & 0,28 \\ 0,55 & 0,57 & 0,69 & 0,27 & 0,42 \\ 0,22 & 0,11 & 0,69 & 0,54 & 0,70 \end{pmatrix}$$

- Calculate the optimization value Information

- 5 $i : 1,2,3, \dots, g$ is an attribute or criterion with maximized status
- $j : g+1, g+2, g+3, \dots, n$ is an attribute or criterion with minimized status
- y^*j : Normalization Matrixmax-min alternative j

To calculate the optimization value, in this example case each criterion has no weight. This optimization value is calculated for each alternative that is by adding the attribute with the type of benefit with other benefit type attributes. Attributes of the type of cost will be added together with other cost attributes. The y value is obtained by subtracting the sum of the benefits and costs.

The results of the calculation of the value of maximax and minimax

Table 10. Optimization calculation results.

| Alternative | Criteria | | | | | Y=max-min |
|-------------|-------------------------|-------------------|------------------------|-------------------|----------------------|-----------|
| | Membership Status (max) | Loan Status (max) | Great Submission (min) | Requirement (max) | Period of time (min) | |
| A1 | 0,55 | 0,11 | 0,69 | 0,67 | 0,28 | 0,36 |
| A2 | 0,55 | 0,57 | 0,14 | 0,40 | 0,42 | 0,96 |
| A3 | 0,22 | 0,57 | 0,14 | 0,13 | 0,28 | 0,5 |
| A4 | 0,55 | 0,57 | 0,69 | 0,27 | 0,42 | 0,28 |
| A5 | 0,22 | 0,11 | 0,69 | 0,54 | 0,70 | -0,52 |

- Determine Priorates Ranking
The final step is determining ranking. Ranking is seen from the value of y_i obtained. The alternative which has the highest value of y_i is the best alternative to become the priority of lending.

Table 11. Ranking results.

| Alternative | Value | Ranking |
|-------------|-------|---------|
| A2 | 0,96 | 1 |
| A1 | 0,36 | 2 |
| A3 | 0,5 | 3 |
| A4 | 0,28 | 4 |
| A5 | -0,52 | 5 |

So that the result of this DSS MOORA is chosen alternative $y^* 2 =$ (Idar) with an optimization value of 0.96.

4. Conclusion

Based on the discussion of research in the development of this application, then conclusions can be taken as follows:

- The MOORA method can be implemented into the system to determine the priority of credit worthiness
- The decision support system that has been established can accelerate the process of selecting the feasibility of borrowers.

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